AERO Design Ltd.

ENGINEERING REPORT

ER926.01

HELICOPTER QUICK RELEASE CARGO BASKETS
HELICOPTER QUICK RELEASE STEPS
ALTERNATE STUD FITTING FABRICATION

Prepared by: Jeff Clarke, CET

Approved by: E. Burgoin, P.Eng., DAR 290M

Revision 0, 27 August 2012

AERO Design Ltd.
Engineering Consultants
www.aerodesign.ca

2013 – 39th Avenue N.E., Calgary, Alberta T2E 6R7
Phone: (403) 250-8027
Fax: (403) 250-8333

TABLE OF CONTENTS

1.0 INTRODUCTION

Extended lead times is an issue with acquiring the Ancra stud fittings used to attach AERO Design Ltd. quick release cargo baskets and steps to the mounting beams. AERO Design Ltd. now has the capability to manufacture these parts "in house".

This report will document testing of the replacement fitting to demonstrate that the part fabricated by AERO Design Ltd. is an acceptable alternative to the Ancra part, when used on cargo baskets and steps.

2.0 REFERENCE TEXT

AERO Design Ltd. Engineering Reports for Cargo Basket certification (multiple)

AERO Design Ltd. Cargo Basket Assembly Drawings

AERO Design Ltd. Step Assembly Drawings

3.0 BASIS OF CERTIFICATION

This report demonstrates that the installation of the new stud fitting complies with the original basis of certification for each model of helicopter cargo basket or step as applicable. Refer to each STC for basis of certification.

4.0 APPLICABILITY OF AIRWORTHINESS DIRECTIVES

This modification does not affect compliance with Airworthiness Directives applicable to the models to which the cargo baskets and steps may be installed.

5.0 LOADS

The critical condition for the stud is the Eurocopter AS350 extra large cargo basket. It has the greatest weight, and the AS350 has the highest dive speed of all the models of basket.

5.1 Load Factors

FAR 27.561(b)(3)

	Ultimate Upward Emergency Landing Load Factor:	$n_{e\_up} := 1.5$
	Ultimate Forward Emergency Landing Load Factor:	$n_{e\_fwd} := 4.0$
	Ultimate Sideward Emergency Landing Load Factor:	$n_{e\_side} := 2.0$
	Ultimate Downward Emergency Landing Load Factor:	$n_{e\_down} := 4.0$
FAR 27.625	Fitting Factor (does not apply to articles being tested):	$n_{ff} := 1.15$
FAR 27.303	Safety Factor:	$n_{sf} := 1.5$

FAR 27.337(a)

	Limit Positive Maneuvering Load Factor:	$n_{man} := 3.5$
$n_{man\_ult} := n_{man} \cdot n_{sf}$	Ultimate Positive Maneuvering Load Factor:	$n_{man\_ult} = 5.25$
	Limit Negative Maneuvering Load Factor:	$n_{man\_neg} := -1.0$
$n_{man\_neg\_u} := n_{man\_neg} \cdot n_{sf}$	Ultimate Negative Maneuvering Load Factor:	$n_{man\_neg\_u} = -1.5$

CRITICAL ULTIMATE LOAD FACTORS:

Downward:	Ultimate Positive Maneuvering Load Factor:	$n_{man\_ult} = 5.25$
Forward:	Ultimate Forward Emergency Landing Load Factor:	$n_{e\_fwd} = 4$
Sideward:	Ultimate Sideward Emergency Landing Load Factor:	$n_{e\_side} = 2$
Upward:	Ultimate Upward Emergency Landing Load Factor:	$n_{e\_up} = 1.5$

Note: The basket is mounted below and to one side of the cabin. Forward deflection or failure in the emergency landing condition does not endanger the occupants. Likewise, Sideward and Upward deflection or failure of the basket in the emergency landing condition do not endanger the occupants.

5.2 Inertia Load

Quick Release Cargo Basket - AS350 XL Long

$W_{basket} := 80 \cdot lbf$ Weight of basket (including options, basic basket is less)

$W_{body} := 55 \cdot lbf$ Weight of basket body (without lid - as used in test).

$W_{cargo} := 300 \cdot lbf$ Weight of cargo (max)

$P_{man\_lim} := (W_{basket} + W_{cargo}) \cdot n_{man\_lim}$

$P_{man\_lim} = 1330 lbf$ Limit maneuvering load due to cargo and basket

$P_{man\_ult} := P_{man\_lim} \cdot n_{sf}$

$P_{man\_ult} = 1995 lbf$ Ultimate maneuvering load due to cargo and basket

5.3 Drag Load

$\rho := 0.002378 \frac{slug}{ft^3}$ Density of air at Sea Level.

$V_{ne} := 155 \cdot knots$ Never-Exceed-Speed of AS350B3.
(Ref. AS350 TCDS)
(Highest of AS350/AS355 Series)

$V_d := \frac{V_{ne}}{0.9}$

$V_d = 172 knots$ Design Dive Speed of AS350B3

$l_{basket} := 96.5 \cdot in$ Length of basket.

$w_{basket} := 25.5 \cdot in$ Width of basket.

$h_{basket} := 19.75 \cdot in$ Height of basket.

$A_f := 443 \cdot in^2$ Frontal Area of basket.

$A_p := l_{basket} \cdot w_{basket}$

$A_p = 2461 in^2$ Planar Area of basket.

$\frac{l_{basket}}{w_{basket}} = 3.8$ Fineness ratio of basket

$C_{Do} := 1.1$ Drag Coefficient of Basket, (overestimated)
(Ref. Hoerner, Fluid Dynamic Drag, Figure 22).

$\rho := 0.002378 \frac{slug}{ft^3}$ Density of air at Sea Level.

$V_{ne} := 155 \cdot knots$ Never-Exceed-Speed of AS350B3.
(Ref. AS350 TCDS.)
(Highest of AS350/AS355 Series.)

$V_d := \frac{V_{ne}}{0.9}$

$V_d = 172knots$ Design Dive Speed of AS350B3

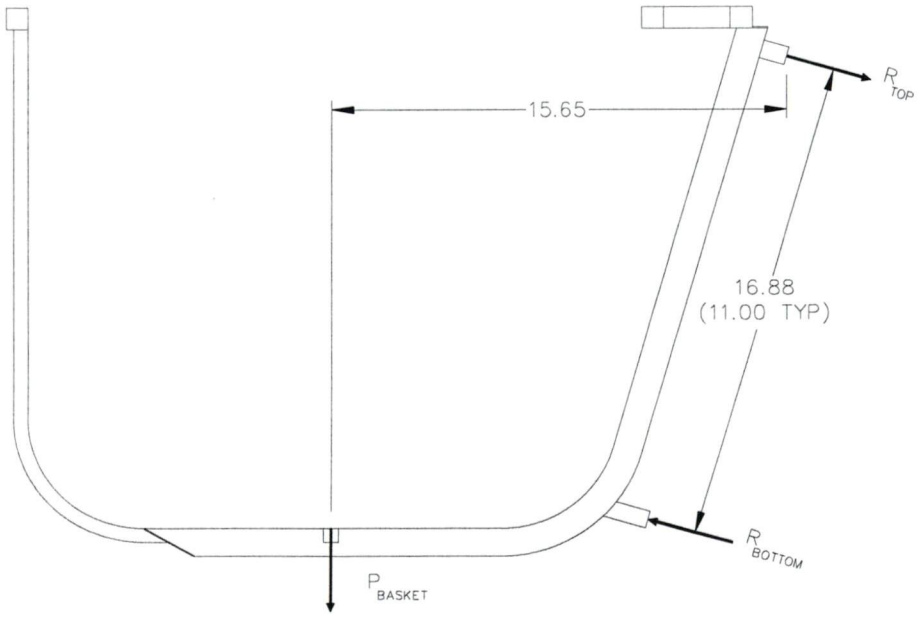
$P_{drag\_lim} := \frac{\rho}{2} \cdot V_d^2 \cdot A_f C_{Do}$

$P_{drag\_lim} = 340lbf$ Limit Drag load on basket.

$P_{drag\_ult} := P_{drag\_lim} \cdot n_{sf}$

$P_{drag\_ult} = 510lbf$ Ultimate Drag load on basket.

5.4 Stud Loads



The arrangement of the lugs and slots has the top lug carrying the vertical component of the load. The drag load is carried by the attachments at one end of the basket. Therefore the critical lug has the combined vertical and drag loads in shear, and the reaction load in tension.

$$P_{basket} := \frac{P_{man\_ult}}{2}\left(n_{ff}\right)$$

$P_{basket} = 1147.1\text{lbf}$ Ultimate load due to basket and cargo

$$R_{top} := \frac{\left(P_{basket} \cdot 16 \cdot \text{in}\right)}{11 \cdot \text{in}}$$

$R_{top} = 1668.5\text{lbf}$ Ultimate tension reaction on top fitting

$R_v := P_{basket}$

$R_v = 1147.1\text{lbf}$ Ultimate vertical shear reaction

$$R_d := \frac{P_{drag\_ult}}{2}$$

$R_d = 255\text{lbf}$ Ultimate drag shear reaction

$$R_{shear} := \sqrt{R_v^{\,2} + R_d^{\,2}}$$

$R_{shear} = 1175.1\text{lbf}$ Ultimate shear reaction on top fitting

6.0 STRUCTURAL COMPLIANCE

6.1 Analysis

Shear

$R_{shear} = 1175.1\text{lbf}$ Ultimate shear reaction on top fitting

$A_{shear} := 0.11045\text{in}^2$ Shear area through shank

$$f_s := \frac{R_{shear}}{A_{shear}}$$

$f_s = 10.6\text{ksi}$ Ultimate shear stress

Yield and ultimate shear strengths are not provided in QQ-S-763F.

Tension

$R_{top} = 1668.5lbf$ Ultimate tension reaction on top fitting

$A_{tension} := 0.082397in^2$ Tension area through thread

$$f_t := \frac{R_{top}}{A_{tension}}$$

$f_t = 20.3ksi$ Ultimate tensile stress

$F_{t\_y} := 30 \cdot ksi$ Yield tensile strength (minimum)
(Ref: QQ-A-763F, Class 316, Cond. A)

The ultimate applied loads do not approach the yield strength of the material. This analysis does not consider a stress concentration at the changes in section. To ensure adequate strength the part was tested.

6.2 Test

6.2.1 Tension

The stud was seated with the head in a steel bar, and threaded into a rod attached to an eye fitting, and pulled with a chain come-along attached to a load cell.

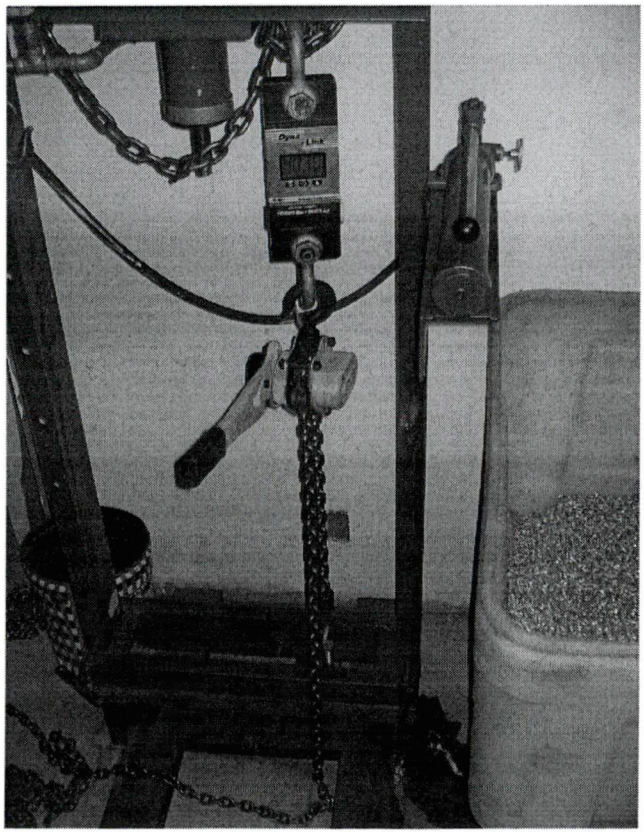


Figure 6.2.1 – Tension test setup

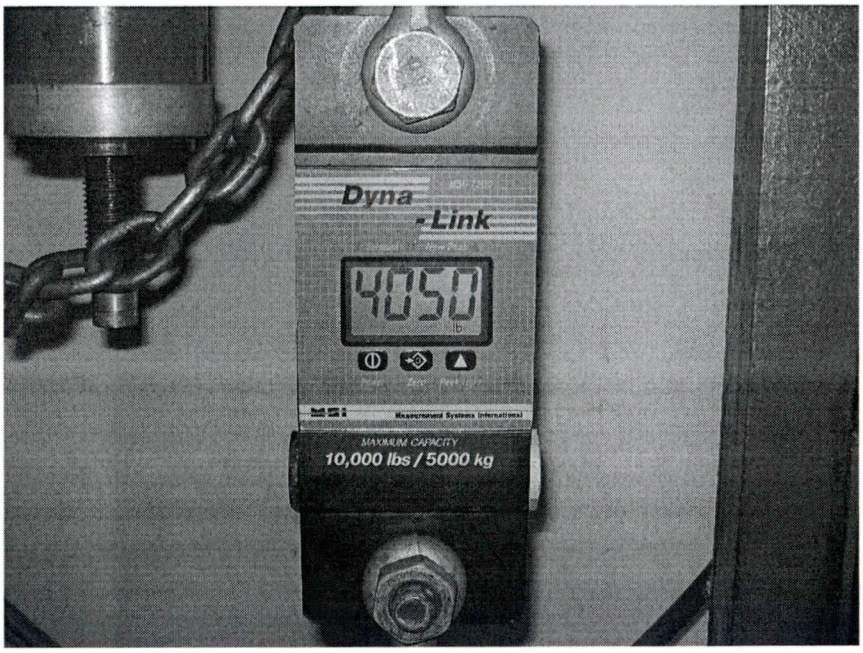


Figure 6.2.1 – Tension Load

The test was limited by capacity of the chain-along, which is rated at 1.5 tons. A tension load of 4050 lbs was applied for more than 3 seconds. The load was removed and the stud inspected for damage. There was no damage or permanent deformation found.

Since there was no deformation found with tension well in excess of the tension load applied by the basket, the part was not tested in shear.

7.0 IMPLEMENTATION

To save time and cost of revising all STCs, this change is implemented by issuing an Engineering Order, EO967.90, which specifies the replacement parts.

When the approval for each specific model of cargo basket is revised, this change is to be incorporated on the drawings at that time.

AERO Design Ltd.

ENGINEERING ORDER

EO 967.90

HELICOPTER QUICK RELEASE CARGO BASKETS
HELICOPTER QUICK RELEASE STEPS
ALTERNATE STUD FITTING

Prepared by: Jeff Clarke, CET

Approved by: E. Burgoin, P.Eng., DAR 290M

Revision 0, 27 August 2012

AERO Design Ltd.
Engineering Consultants
www.aerodesign.ca

2013 – 39th Avenue N.E., Calgary, Alberta T2E 6R7
Phone: (403) 250-8027
Fax: (403) 250-8333

1.0 INTRODUCTION

This Engineering Order is provided to allow for the use of stainless steel fittings made by AERO Design Ltd. in place of the Ancra 40088-14 fittings specified for AERO Design Ltd. quick release cargo baskets and steps for various models of helicopter.

2.0 REFERENCE TEXT

AERO Design Ltd. Drawings:

Robinson R44: 90610

Eurocopter AS350/AS355:78410, 77610, 76410, 82716

Bell 206B: 80210, 80310, 81110

Bell 206L/407: 76610, 69810, 80010

Bell 205A-1/212: 75110

3.0 IMPLEMENTATION

Stud fitting part number 96710-01 may be used as an alternate to Ancra part number 40088-14, when used on AERO Design Ltd. cargo baskets and steps. Apply copper-based anti-seize compound, Loctite C5-A or equivalent, to threads of stud fitting prior to installation. Torque stud fitting to 160-190 in-lbs.

This engineering order applies to all AERO Design Ltd. quick release cargo basket and step configurations including, but not limited to, those listed in section 2.0.

Fitting part number 96710-01 shall not be used to replace Ancra part number 40088-14 in any other application.

INCH-POUND

NOTICE
OF VALIDATION

MS21234
NOTICE 1
21 June 1991

MILITARY SPECIFICATION

FITTING, TIEDOWN , CARGO RING (5,000 lb) AND SEAT STUD, TYPE I

MS21234, dated 1 December 1967, has been reviewed and determined to be valid for use in acquisition.

Custodians:
Navy - AS
Army - GL
Air Force - 99

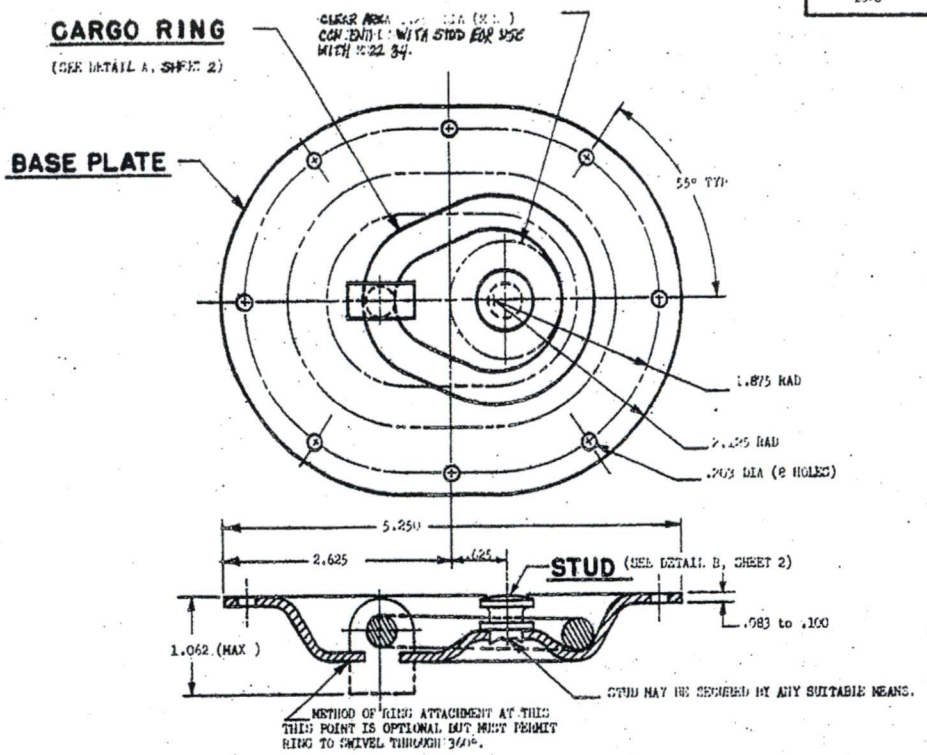
Preparing Activity:
Navy - AS

AMSC N/A

FSC 1670

DISTRIBUTION STATEMENT A. Approved for public release, distribution is unlimited.

FED. SUP CLASS
1670



MATERIAL: SEE PROCUREMENT SPECIFICATION.

HEAT TREAT: SEE PROCUREMENT SPECIFICATION.

REMOVE ALL BURRS AND SHARP EDGES.

DIMENSIONS IN INCHES. UNLESS OTHERWISE SPECIFIED, TOLERANCES: FRACTIONS ±1/64, DECIMALS ±.005, ANGLES ±1/2°.

FOR DESIGN FEATURE PURPOSES, THIS STANDARD TAKES PRECEDENCE OVER PROCUREMENT DOCUMENTS REFERENCED HEREIN.

REFERENCED DOCUMENTS SHALL BE OF THE ISSUE IN EFFECT ON DATE OF INVITATIONS FOR BID.

APPROVED 1 DEC 67 REVISED

P.A. NAVY - AS Other Cust ARMY - GL USAF - 11	TITLE FITTING, TIEDOWN, CARGO RING (5000 LB) AND SEAT STUD, TYPE I	MILITARY STANDARD MS21234
PROCUREMENT SPECIFICATION MIL-A-8905	SUPERSEDES:	SHEET _ OF 2

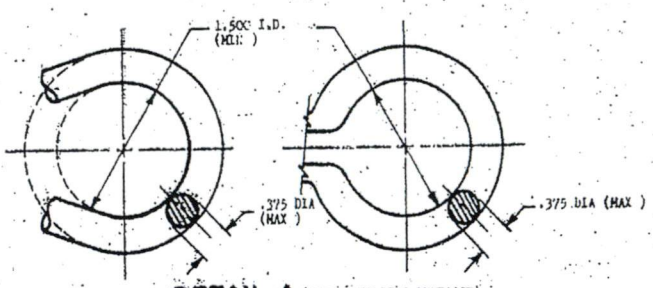
DD FORM 672-1 (Coordinated) PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

User activities:

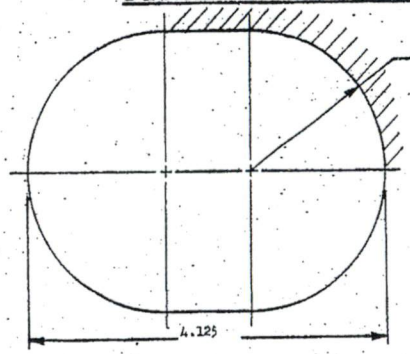
Review activities:
USAF - 11, 82
ARMY - GL, AV
NAVY - AS

This military standard has been approved by the Department of Defense and is mandatory for use by all Departments and Agencies of the Department of Defense. Selection for all new engineering and design applications and for repetitive use shall be made from this document.

FED. SUP CLASS
1670

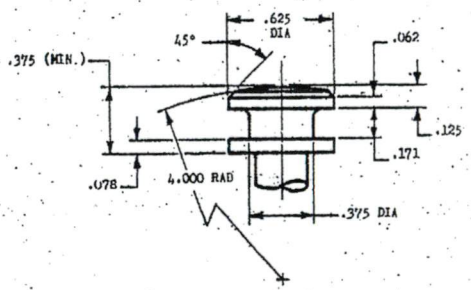


DETAIL A (ALLOWABLE RING ENVELOPE)



FLOOR CUTOUT

FITTING MUST INSTALL INTO FLOOR CUTOUT SHOWN ABOVE WITHOUT INTERFERENCE.



DETAIL B
(ENLARGED)

APPROVED, 1 DEC 67 REVISED

User activities:

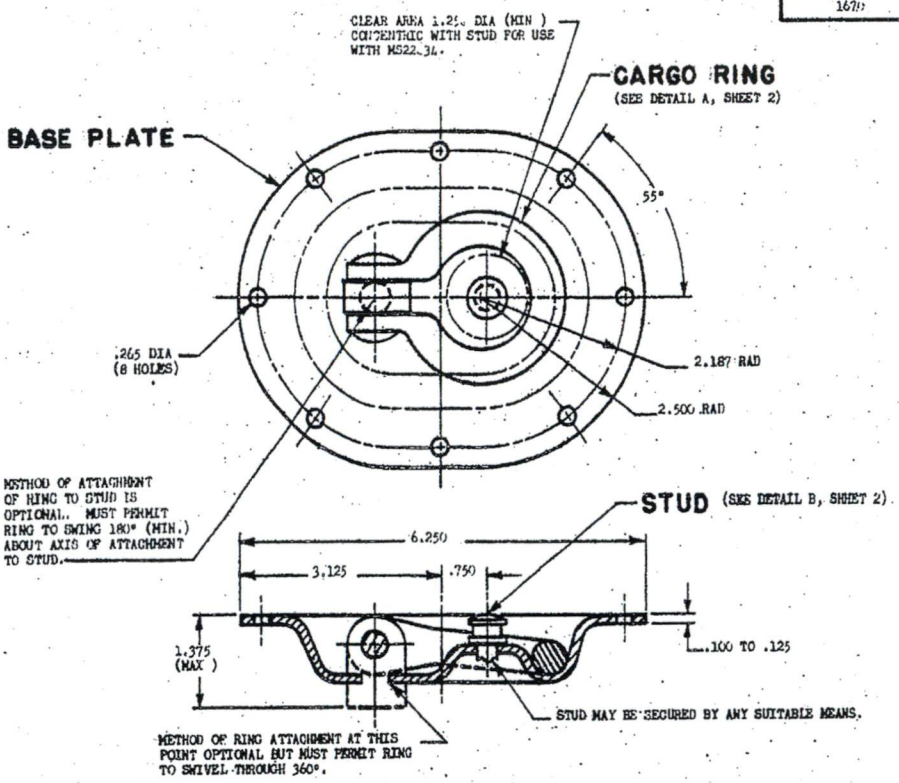
Review activities:
DSAH-TI, FE
ARMY-GL, AV
NAVY-AS

P.A. NAVY - AS Other Cost ARMY - GL USAF - 11	TITLE FITTING, TIEDOWN, CARGO RING (5000 LB) AND SEAT STUD, TYPE I	MILITARY STANDARD MS21234
PROCUREMENT SPECIFICATION MIL-A-8905	SUPERSEDES:	SHEET 2 OF 2

DD FORM SEP 67 672-1 (Coordinated)

PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

FED. SUP CLASS
16710



MATERIAL: SEE PROCUREMENT SPECIFICATION.

HEAT TREAT: SEE PROCUREMENT SPECIFICATION.

REMOVE ALL BURRS AND SHARP EDGES.

DIMENSIONS IN INCHES. UNLESS OTHERWISE SPECIFIED, TOLERANCES: FRACTIONS ±1/64, DECIMALS ±.005, ANGLES ±1/2°.

FOR DESIGN FEATURE PURPOSED, THIS STANDARD TAKES PRECEDENCE OVER PROCUREMENT DOCUMENTS REFERENCED HEREIN.

REFERENCED DOCUMENTS SHALL BE OF THE ISSUE IN EFFECT ON DATE OF INVITATIONS FOR BID.

APPROVED 1 Dec 67 REVISED

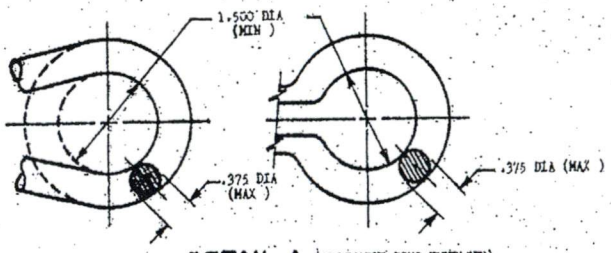
P.A. NAVY - AS Other Cust ARMY - GL USAF - 11	TITLE FITTING, TIEDOWN, CARGO RING (10,000 LB) AND SEAT STUD, TYPE II	MILITARY STANDARD MS 21235
PROCUREMENT SPECIFICATION MIL-A-8905	SUPERSEDES:	SHEET 1 OF 2

DD FORM 1 NOV 65 672-1 (Coordinated) PREVIOUS EDITIONS OF THIS FORM ARE OBSOLETE.

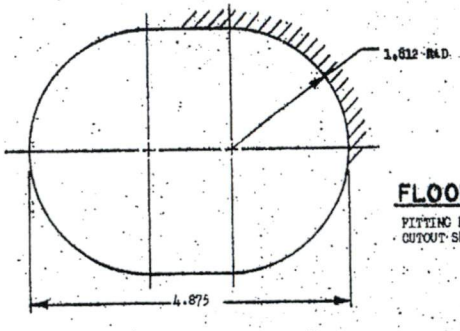
User activities:

Review activities:
USAF-11,82
ARMY-GL,AV
NAVY-AS.

FED. SUP CLASS
1670

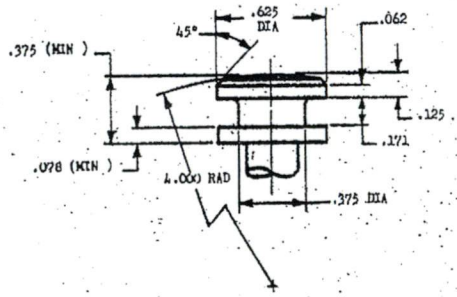


DETAIL A (ALLOWABLE RING ENVELOPE)



FLOOR CUTOUT

FITTING MUST INSTALL INTO FLOOR CUTOUT SHOWN ABOVE WITHOUT INTERFERENCE.



DETAIL B
(ENLARGED)

APPROVED 1 DEC 67 REVISED

This military standard has been approved by the Department of Defense and is mandatory for use by all Departments and Agencies of the Department of Defense. Selection for all new engineering and design applications and for repetitive use shall be made from this document.

User activities:
USAF-11,82
ARMY-GL,AV
NAVY-AS

User activities:

P.A. NAVY - AS Other Cust ARMY - GL USAF - 11	TITLE FITTING, TIEDOWN, CARGO RING (10,000 LB) AND SEAT STUD, TYPE II	MILITARY STANDARD MS 21235
PROCUREMENT SPECIFICATION MIL-A-8905	SUPERSEDES:	SHEET 2 OF 2

DD FORM 672-1 (Coordinated)

Table III Mechanical properties

Classes	Condition	Finish	Diameter or Thickness inches	Yield strength (min) 0 2 percent offset psi	Ultimate tensile strength (min)	Elongation in 2 inches (min) percent	reduction in area (min) percent	Brinnell hardness (max) 4/
202, 302, 304, 305 309, 310, 316 317, 321, 347	A	Hot	0 500 and less	-----	115,000 (max)	----	----	----
			over 0 500	30,000	75,000 1/	40	50	----
		Cold	0 500 and less	-----	125,000 (max)	---	----	----
			over 0 500	30,000	75,000 1/	30	50	----
202, 302, 304	B	Cold	0 500 and less	---	125/155,000	----	----	----
			over 0 500 to 0 750	100,000	125,000	12	35	----
			0 751 to 1 000	80,000	115,000	15	35	----
			1 001 to 1 250	65,000	105,000	20	35	----
			1 251 to 1 500	50,000	100,000	28	45	----
			1 501 to 1 750	45,000	95,000	30	45	----
			over 1 750	30,000	75,000	35	50	----
316, 317	B	Cold	0 500 and less	----	110/140,000	----	----	----
			0 501 to 0 750	95,000	110,000	15	45	----
			0 751 to 1 000	80,000	100,000	20	45	----
			1 001 to 1 250	65,000	95,000	25	45	----
			1 251 to 1 500	50,000	90,000	30	45	----
304L 316L	A	Hot	0 500 and less	----	115,000 (max)	----	----	----
			over 0.500	25,000	70,000	40	50	----
		Cold	0 500 and less	----	115,000 (max)	----	----	----
			over 0 500	25,000	70,000	30	40	----

Hex rod from EMJ

K110+3 R773270

From: ESP Specialty Steel Products Date: 7/24/2012 To: EARLE M.JORGENSEN(CHICAGO) SO#: S051915 Ln#: 1
PO#: P463114 Part: 13400621 Qty: 1415 Heat#: 3R325 Tag: 123046

WALSIN LIHWA CORPORATION YENSHUI PLANT
ISO 9001,ISO 14001 CERTIFIED
MILL TEST / INSPECTION CERTIFICATE

WALSIN LIHWA CORP. YENSHUI PLANT
台塑市鹽水區排水里溪頂12鄰32-10號
NO.3-10, SHUIOU LIAU, CHIN SHUI LI,
YENSHUI DIST TAINAN CITY 73743,TAIWAN,R.O.C.
TEL.: 886-6-652-0911 FAX: 886-6-652-0934

CUSTOMER :	ENERGY STEEL PRODUCTS			DATE OF ISSUE :	2011/10/31	File	A1111010231
Steel Grade:	316/L	Commodity:	Stainless Steel Bar	ORDER NO. :	10003B021/	LC NO:	

Item	Heat No.	Shape	Size (inch)	Quantity(Pcs)	Weight (LBS)	Condition	Remark	Workmanship
1 →	3R325	H	0.625"	180	2505.95	Cold Drawn		Macro and micro structure : ok No welding repaired Country of melted & Manufactured: Taiwan Material is free from mercury contamination Intergranular corrosion test by ASTM A262 Practice B: OK Solution annealed treatment: Acc. to ASTM A484 Grain size per ASTM E112
2 →	3R069	H	0.625"	95	1322.40	Cold Drawn		

Heat No.		Chemical Composition(wt%)													Mechanical Property					
		C x100	Si x100	Mn x100	P x1000	S x1000	Ni x100	Cr x100	Mo x100	Cu x100	N x10000				TS KSI	YS KSI	EL %	RA %	HRB	
	Spec Min						1000	1600	200											
	Max	3	100	200	45	30	1400	1800	300		1000									
3R069		1.8	37	183	27	28.1	1000	1710	200	59	543				101	60	39	68	96	
3R325		1.9	40	168	26	28.1	1001	1672	203	59	554				101	60	39	68	96	

Remark:
This inspection is issued according to EN 10204 3.1.
Acc. to ASTM A276/A479/A484 and AMS QQS-763 Cond.A.
Acc. to ASME SA479/SA182/SA193
Acc. to ASTM A182/193/320 B8M/AMS 5653, 5648 chemistry only.
Acc. to NACE MR0103/MR0175 table A2 & D1.

Condition:
S-Solution Treated
HR-Hot Rolled
CD-Cold Drawn
ST-Smooth Turned
CG-Centerless Ground
A-Annealed
P-Polished
PL-Pealed

Shape:
R:Round
H:Hexagonal
S:Square
SR:Square-Round
E:Ellipse
FB:Rectangular

Here we certify that the material described herein has been manufactured and tested with satisfactory results in accordance with the requirement of the above material specification.

Quality Assurance Responsible Personnel SL Kuan.

This report is a copy of original mill certificate and verifies that the product meets the requirements as originally ordered by Energy Steel Products.

8/8/12